

XXXII.

FOOD AND HEALTH.

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I have come to the conclusion that more than half the disease which embitters the middle and latter part of life is due to avoidable errors in diet, . . . and that more mischief in the form of actual disease, of impaired vigor, and of shortened life accrues to civilized man . . . in England and throughout Central Europe from erroneous habits of eating, than from the habitual use of alcoholic drink, considerable as I know that evil to be.—*Sir Henry Thompson.*

I have quoted the above, from an eminent physician, because it expresses a belief which is current among hygienists, and because it coincides with observations of my own made from the somewhat different standpoint of the physiological chemist.

The error which Sir Henry Thompson most seriously deplors is over-eating. "It is a failure to understand, first, the importance of preserving a near equality between the supply of nutriment to the body and the expenditure produced by the activity of the latter, and, secondly, ignorance of the method of attaining this object in practice, which gives rise to the various forms of disease calculated to embitter and shorten life."

The object of the present paper is to call attention very briefly and without detailed discussion to some statistics of food and dietaries which imply that we as a people, or at least many of us, are more addicted to the habit of over-eating than we realize. The statistics are the result of two investigations prosecuted under my direction, in the chemical laboratory of Wesleyan University. One of these investigations was made at the instance, and with the aid, of the Smithsonian Institution and the U. S. Fish Commission, on the composition of some of our more common food materials. The other, on dietaries, especially of working people, was made in connection with the Massachusetts Bureau of Statistics of Labor. They indicate that in this country not only well-to-do people, but those in moderate circumstances also, use a needless quantity of food; that part of this excess, however, is simply thrown away, so that the injury to health, however great, is doubtless much less than if all were eaten; that one great fault with our dietaries is an excess of meats and perhaps of sweetmeats; that even among those who desire to economize there is great pecuniary loss from the selection of materials in which the actual nutrients are actually, though not apparently, dearer than need be; that many people whose means are limited make still

CHART I.

Nutritive Ingredients and Refuse, and Amount of Potential Energy in Food Materials.

PERCENTAGES INDICATED BY SHADED SPACES.

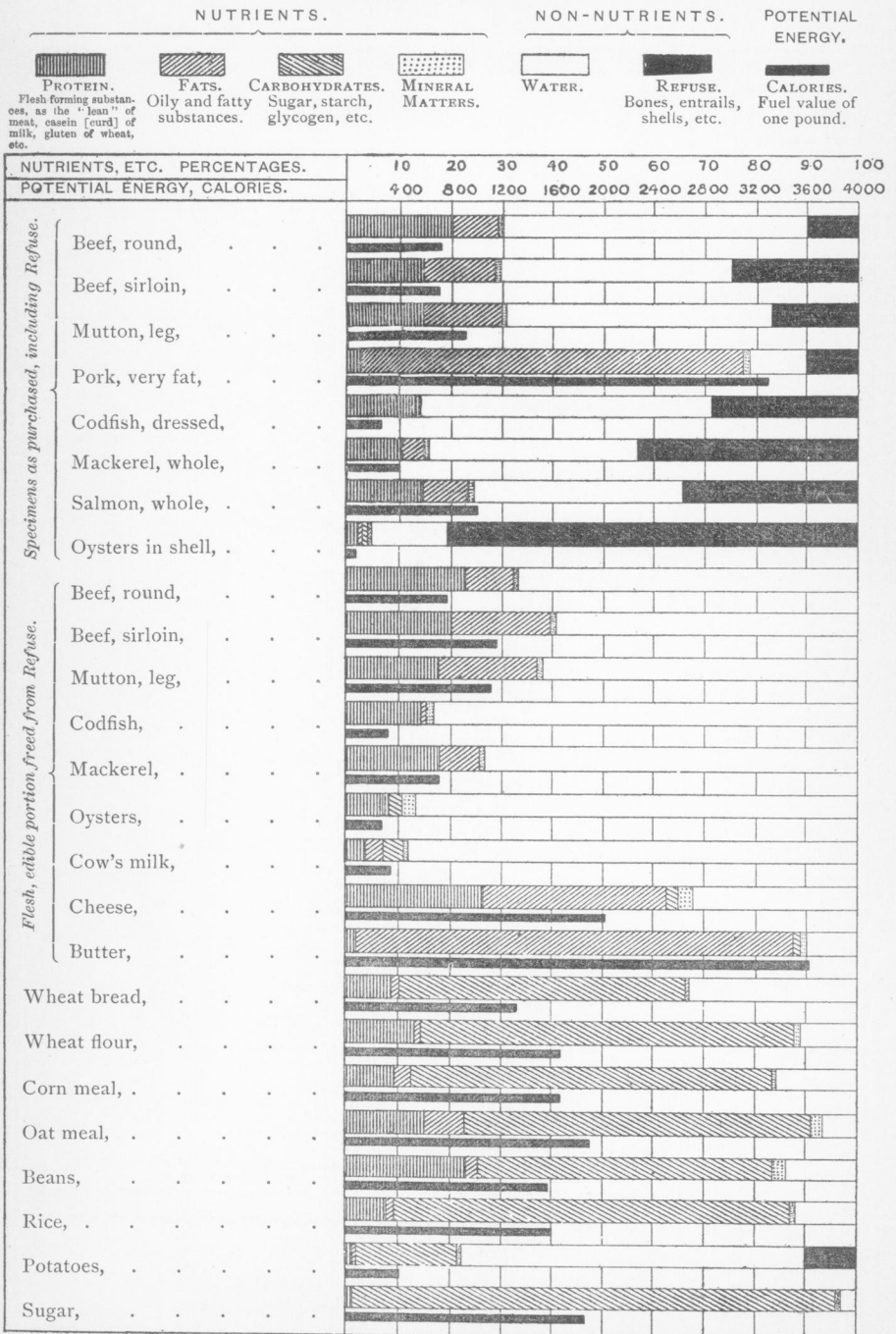
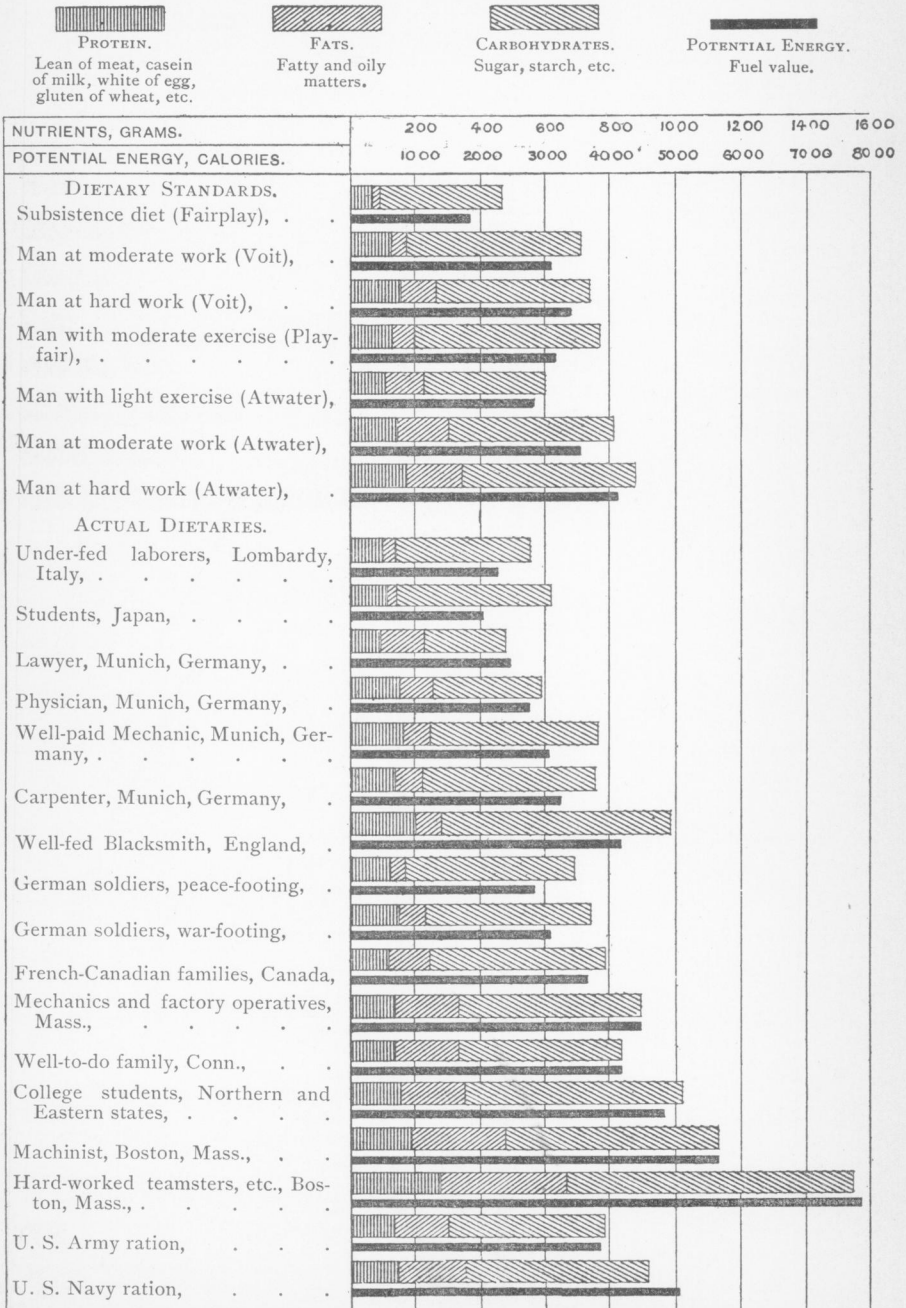


CHART II.

Standards for Daily Dieteries and Actual Dieteries of People of Different Classes.

WEIGHTS OF NUTRIENTS AND CALORIES OF ENERGY IN NUTRIENTS IN FOOD PER DAY.



more serious mistakes in their choice of food, so that they are often inadequately nourished when they might be well fed at less cost; and, what seems the most painful thing of all, that it is generally the very poor who practice the worst economy in the purchase, as well as in the use, of their food. It is, however, of the relations between the demands of the body for nourishment and the food ordinarily consumed, that I wish particularly to speak.

Before entering upon the special theme, it may be well to recapitulate very briefly some of the fundamental principles of the theory of nutrition to which the latest research has led. For this purpose we must consider the ingredients of our food materials, and their functions in nutrition.

The following tables and explanatory statements are an attempt to epitomize some results of late research, a considerable portion of which have not yet become current in treatises in English.¹ Those regarding digestibility, potential energy, and functions of nutrients are based upon experimental inquiry in Europe, especially in Germany. The data employed for the tables of dietary standards and actual dietaries are mainly European, but include a considerable number of the results of observations above referred to as made in the United States. The figures for the composition of food-materials are taken mostly from the investigations which were mentioned above as executed in behalf of the Smithsonian Institution and the United States Fish Commission, but the results of which still await detailed publication.

INGREDIENTS OF FOOD-MATERIALS.—NUTRIENTS AND NON-NUTRIENTS.

Our ordinary food-materials, such as meat, fish, eggs, potatoes, wheat, etc., consist of—

Refuse, as the bones of meat and fish, shells of eggs, skin of potatoes, and bran of wheat.

Edible portion, as the flesh of meat and fish, white and yolk of eggs, wheat flour.

The edible substance consists of—

Water.

Nutritive ingredients or Nutrients.

The principal kinds of nutrients are—

1. *Protein.*
2. *Fats.*
3. *Carbohydrates.*
4. *Mineral matters.*

Water, refuse, and the salt of salted meat and fish are called non-nutrients. The water contained in foods and beverages has the same composition and properties as other water; it is, of course, indispensable for nourishment, but is not a nutrient in the sense in which the term

¹ See articles on the Chemistry of Food and Nutrition in *Century Magazine* for 1887 and 1888. The statements and tables which follow are in large part adopted from these, and from an article in Vol. I of the National Medical Dictionary.

is here used. In comparing the values of different food-materials for nourishment, the refuse and water are left out of account.

The nutritive materials or nutrients may be divided into several classes, of which the most important are protein, fats, carbohydrates, and mineral matters. Of course there are compounds which properly do not belong to either of these classes, but for our present purpose they may be neglected.

The following are familiar examples of compounds of each of the four principal classes of nutrients :

PROTEIN—*a.* Albuminoids, *e. g.*, albumen (white of eggs); casein (curd) of milk; myosin, the basis of muscle (lean meat); gluten of wheat, etc. *b.* Gelatinoids: *e. g.*, collagen of tendons; ossein of bones, which yield gelatine or glue. (Meats and fish contain very small quantities of so-called "extractives." They include kreatin and allied compounds, and are the chief ingredients of beef-tea and meat-extract. They contain nitrogen, and hence are commonly classed with protein.)

FATS—*e. g.*, fat of meat; fat of milk (butter); olive oil; oil of corn, wheat, etc.

CARBOHYDRATES—*e. g.*, sugar, starch, cellulose (woody fibre).

MINERAL MATTERS—*e. g.*, calcium phosphate or phosphate of lime; sodium chloride (common salt).

It is to be especially noted that the protein compounds contain nitrogen, while the fats and carbohydrates have none. The albuminoids and gelatinoids are frequently classed together as proteids. The term "proteids" is also used to include all the nitrogenous ingredients—*i. e.*, synonymous with protein. The average composition of these compounds is about as follows :

	Protein.	Fats.	Carbohydrates.
Carbon,	53 per cent.	76.5 per cent.	44 per cent.
Hydrogen,	7 "	12.0 "	6 "
Oxygen,	24 "	11.5 "	50 "
Nitrogen,	16 "	None.	None.
	<hr/> 100 per cent.	<hr/> 100 per cent.	<hr/> 100 per cent.

Different specimens of the same kind of food-material differ widely in composition. The figures in Table I, herewith, represent the average of analyses, of which those of fruits and beverages are European, and the rest American.

TABLE I.

Percentages of Nutrients (Nutritive Ingredients), water, etc., and estimated potential energy (fuel-value) in specimens of food-materials.

FOOD-MATERIALS.	REFUSE: bones, skin, shells, etc.	EDIBLE PORTION.						Calories of potential energy in 1 pound of each material.
		Water.	Nutrients.					
			Total.	Protein.	Fats.	Car- bohy- drates.	Mineral matters.	
<i>Animal foods as pur- chased, including edible portion and refuse:</i>	per cent.	per ct.	per ct.	per cent.	per ct.	per ct.	per cent.	
Beef, side ¹	19.7	44.0	36.3	13.8	21.7	.....	0.8	1170
Beef, round ¹	10.0	60.0	30.0	20.7	8.1	.....	1.2	725
Beef, neck ¹	19.9	49.6	30.5	15.4	14.3	.....	0.8	890
Beef, sirloin ¹	25.0	45.0	30.0	15.0	14.3	.....	0.7	885
Beef, flank ¹	11.7	24.2	64.1	10.6	52.9	.....	0.6	2430
Mutton, side ¹	20.0	42.9	37.1	13.2	23.2	.....	0.7	1225
Mutton, leg ¹	18.4	50.4	31.2	15.0	15.5	.....	0.7	935
Mutton, shoulder ¹	16.8	48.7	34.5	15.0	18.7	.....	0.8	1070
Mutton, loin (chops) ¹	16.3	41.3	42.4	12.5	29.3	.....	0.6	1470
Smoked ham.....	14.0	36.3	49.7	14.6	34.2	.....	0.9	1715
Pork, very fat.....	10.4	9.5	80.1	2.8	76.5	.....	0.8	3280
Chicken ²	41.6	42.2	16.2	14.2	1.2	.....	0.8	315
Turkey.....	35.4	42.8	21.8	15.4	5.6	.....	0.8	525
Flounder, whole.....	66.8	27.2	6.0	5.2	0.3	.....	0.5	110
Haddock, dressed.....	51.0	40.0	9.0	8.2	0.2	.....	0.6	160
Bluefish, dressed.....	48.6	40.3	11.1	9.8	0.6	.....	0.7	210
Brook trout, whole.....	48.1	40.4	11.5	9.8	1.1	.....	0.6	230
Codfish, dressed.....	29.9	58.5	11.6	10.6	0.2	.....	0.8	205
Whitefish, whole.....	53.5	32.5	14.0	10.3	3.0	.....	0.7	320
Shad, whole.....	50.1	35.2	14.7	9.2	4.8	.....	0.7	375
Turbot, whole.....	47.7	37.3	15.0	6.8	7.5	.....	0.7	445
Mackerel, fat, whole.....	33.8	42.4	23.8	12.1	10.7	.....	1.0	675
Mackerel, lean, whole.....	38.3	48.5	13.2	11.2	1.4	.....	0.6	265
Mackerel, average, whole.....	44.6	40.4	15.0	10.0	4.3	.....	0.7	365
Halibut, dressed.....	17.7	61.9	20.4	15.1	4.4	.....	0.9	465
Salmon, whole.....	35.3	40.6	24.1	14.3	8.8	.....	1.0	635
Eel.....	36.0	33.8	30.2	8.6	21.0	.....	0.6	1045
Salt codfish.....	42.1	40.3	17.6	16.0	0.4	.....	1.2	315
Smoked herring.....	50.9	19.2	29.9	20.2	8.8	.....	0.9	745
Salt mackerel.....	40.4	28.1	31.5	14.7	15.1	.....	1.7	910
Canned salmon.....	4.9	59.3	35.8	19.3	15.3	.....	1.2	1005
Canned sardines.....	5.0	53.6	41.4	24.0	12.1	.....	5.3	955
Lobsters.....	62.1	31.0	6.9	5.5	0.7	0.1	0.6	135
Oysters in shell.....	82.3	15.4	2.3	1.1	0.2	0.6	0.4	40
Hens' eggs.....	13.7	63.1	23.2	11.8	10.2	0.4	0.8	655
<i>Animal foods, edible portion:</i>								
Beef, side ¹		54.7	45.3	17.2	27.1	.....	1.0	1465
Beef, round ¹		66.7	33.3	23.0	9.0	.....	1.3	805
Beef, sirloin ¹		60.0	40.0	20.0	19.0	.....	1.0	1175
Mutton, side ¹		45.9	54.1	14.7	38.7	.....	0.7	1905
Mutton, leg ¹		61.8	38.2	18.3	19.0	.....	0.9	1140
Mutton, loin (chops) ¹		49.3	50.7	15.0	35.0	.....	0.7	1755
Flounder.....		84.2	15.8	13.8	0.7	.....	1.3	285
Codfish.....		82.6	17.4	15.8	0.4	.....	1.2	310
Mackerel, fat.....		64.0	36.0	18.2	16.3	.....	1.5	1025
Mackerel, lean.....		78.7	21.3	18.1	2.2	.....	1.0	430
Mackerel, average.....		71.6	28.4	18.8	8.2	.....	1.4	695

¹ From well-fattened animals.² Rather lean.

TABLE I.—*Concluded.*

FOOD-MATERIALS.	REFUSE: bones, skin, shells, etc.	EDIBLE PORTION.						Calories of potential energy in 1 pound of each material.
		Water.	Nutrients.					
			Total.	Protein.	Fats.	Car- bohy- drates.	Mineral matters.	
<i>Animal foods, edible por- tion:</i>	per cent.	per ct.	per ct.	per cent.	per ct.	per ct.	per ct.	
Salmon.....	63.6	36.4	21.6	13.4	.....	1.4	965
Oysters, fat.....	81.7	18.3	8.0	1.7	6.7	1.9	345	
Oysters, lean.....	90.9	9.1	4.2	0.6	1.8	2.5	135	
Oysters, average.....	87.1	12.9	6.0	1.2	3.7	2.0	230	
Hens' eggs.....	73.1	26.9	13.7	11.7	0.5	1.0	760	
Cows' milk.....	87.4	12.6	3.4	3.7	4.8	0.7	310	
Cows' milk, skimmed.....	90.7	9.3	3.1	0.7	4.8	0.7	175	
Cheese, whole milk.....	31.2	68.8	27.1	35.5	2.3	3.9	2045	
Cheese, skimmed milk.....	41.3	58.7	38.4	6.8	8.9	4.6	1165	
Butter.....	10.0	90.0	1.0	85.0	0.5	3.5	3615	
Oleomargarine.....	10.0	90.0	0.6	84.5	0.4	4.5	3585	
Lard.....	1.0	99.0	.....	99.0	.....	.....	4180
<i>Vegetable foods:</i>								
Wheat bread.....	32.7	67.3	8.9	1.9	55.5	1.0	1280	
Wheat flour.....	11.6	88.4	11.1	1.1	75.6	0.6	1660	
Graham flour.....	13.0	87.0	11.7	1.7	71.8	1.8	1625	
Rye flour.....	13.1	86.9	6.7	6.7	78.7	0.7	1620	
Buckwheat flour.....	13.5	86.5	6.5	1.3	77.6	1.1	1620	
Beans.....	13.7	86.3	23.2	2.1	57.4	3.6	1585	
Oatmeal.....	7.7	92.3	15.1	7.1	68.1	2.0	1845	
Corn (maize) meal.....	14.5	85.5	9.1	3.8	71.0	1.6	1650	
Rice.....	12.4	87.6	7.4	0.4	79.4	0.4	1630	
Sugar.....	2.2	97.8	0.3	.....	96.7	0.8	1800
Potatoes.....	10.0	68.0	22.0	1.8	0.2	19.1	0.9	395
Potatoes.....	75.5	24.5	2.0	0.2	21.3	1.0	440	
Sweet potatoes.....	75.8	24.2	1.5	0.4	21.1	1.2	435	
Turnips.....	91.2	8.8	1.0	0.2	6.9	0.7	155	
Carrots.....	87.9	12.1	1.0	0.2	10.1	0.8	215	
Cabbage.....	90.0	10.0	1.9	0.2	6.2	1.2	170	
Melons.....	95.2	4.8	1.1	0.6	2.5	0.6	90	
Apples.....	84.8	15.2	0.4	.....	14.3	0.5	275
Pears.....	83.0	17.0	0.4	.....	16.3	0.3	310
Bananas.....	73.1	26.9	1.9	0.6	23.3	1.1	495	
<i>Beverages:</i>				Alcohol.				
Lager beer.....	90.3	.....	0.4	2.0	5.8	0.2	
Porter and ale.....	88.1	.....	0.6	5.1	6.8	0.4	
Rhine wine, white.....	86.3	.....	.....	9.3	2.3	0.2	
Rhine wine, red.....	86.9	.....	.....	8.1	3.0	0.3	
French wine, claret.....	88.3	.....	.....	8.0	2.3	0.2	
Sherry wine.....	79.5	.....	.....	17.0	3.2	0.3	

¹As purchased, including refuse, skin, etc.

DIGESTIBILITY OF FOOD.

The discussion of such complex questions as the adaptability of different foods to digestive and assimilative capacities of different persons in different conditions of age, health, and otherwise, would be out of place here. The question of the quantities of nutrients digested is a somewhat simpler matter.

Table II epitomizes the results of some sixty experiments, mostly with

men, but a few with children, in which the proportions of the ingredients of food materials actually digested have been found by comparison of amounts and composition of the food eaten with those of the undigested excreta. Table III is computed by applying the data obtained by these experiments to some of those for the composition of food-materials in Table I.

TABLE II.

Digestibility of Nutrients of Food Materials.

In the food-materials below.	Of the total amounts of protein, fats, and carbohydrates, the following percentages were digested:		
	Protein.	Fats.	Carbohydrates.
Meats and fish.....	Practically all.	79 to 92	
Eggs.....	"	96	
Milk.....	88 to 100	93 to 98	?
Butter.....		98	
Oleomargarine.....		96	
Wheat bread.....	81 to 100	?	99
Corn (maize) meal.....	89	?	97
Rice.....	84	?	99
Pease.....	86	?	96
Potatoes.....	74	?	92
Beets.....	72	?	82

TABLE III.

Proportions of Nutrients Digested and not Digested from Food-materials by Healthy Men.

	PROTEIN.			FATS.			CARBOHYDRATES.			Mineral matters.	Water.
	Digestible.	Undigestible.	Total.	Digestible.	Undigestible.	Total.	Digestible.	Undigestible.	Total.		
	per ct.	per ct.	per ct.	per ct.	pr ct.	per ct.	per ct.	pr ct.	pr ct.	pr ct.	pr ct.
Beef, round	23.0	0.0	23.0	8.1	0.9	9.0	0.0	0.0	0.0	1.3	66.7
Beef, sirloin	20.0	0.0	20.0	17.1	1.9	19.0	0.0	0.0	0.0	1.0	60.0
Pork, very fat	3.0	0.0	3.0	74.5	6.0	80.5	. .	. .	. .	6.5	10.0
Haddock,	17.1	0.0	17.1	0.3	. .	0.3	0.0	0.0	0.0	1.2	81.4
Mackerel	18.8	0.0	18.8	7.4	0.8	8.2	0.0	0.0	0.0	1.4	71.6
Hens' eggs	13.4	0.0	13.4	9.4	2.4	11.8	0.7	0.0	0.7	1.0	73.1
Cows' milk	3.4	0.0	3.4	3.6	0.1	3.7	4.8	0.0	4.8	0.7	87.4
Cheese, whole milk	27.1	0.0	27.1	34.6	0.9	35.5	2.3	0.0	2.3	3.9	31.2
Butter	1.0	. .	1.0	85.8	1.7	87.5	0.5	. .	0.5	2.0	9.0
Oleomargarine	0.4	. .	0.4	83.9	3.3	87.2	0.0	. .	0.0	2.1	10.3
Sugar	0.3	. .	0.3	. .	. .	. .	96.7	0.0	96.7	0.8	2.2
Wheat { very fine	7.6	1.3	8.9	1.0	. .	1.0	74.4	0.8	75.2	0.3	14.6
flour { medium	9.5	2.1	11.6	0.8	. .	0.8	70.4	1.8	72.2	0.4	15.0
coarse, whole wh.	8.2	2.7	10.9	1.8	. .	1.8	66.4	5.3	71.7	1.2	14.4
Wheat bread, average	7.7	1.2	8.9	1.9	. .	1.9	54.9	.6	55.5	1.0	32.7
Black bread	4.5	1.6	6.1	. .	. .	. .	43.3	5.3	48.6	1.5	43.8
Pease	19.7	3.2	22.9	1.8	. .	1.8	55.7	2.1	57.8	2.5	15.0
Corn (maize) meal	7.9	1.2	9.1	3.8	. .	3.8	68.7	2.3	71.0	1.6	14.5
Rice	6.2	1.2	7.4	0.4	. .	0.4	78.7	0.7	79.4	0.4	12.4
Potatoes	1.5	0.5	2.0	0.2	. .	0.2	19.7	1.6	21.3	1.0	75.5
Turnips	0.7	0.3	1.0	0.2	. .	0.2	5.6	1.3	6.9	0.7	91.2

POTENTIAL ENERGY OF FOOD.

In being consumed in the body as fuel to furnish heat and muscular energy the nutrients appear to replace one another in proportion to their potential energy, which is accordingly taken as a measure of their fuel-value. The energy is estimated in Calories. The Calorie is the heat which would raise a kilogram of water one degree centigrade (or one pound of water about four degrees Fahrenheit). A foot ton is the energy (power) which would lift one ton one foot. One Calorie corresponds to 1.53 foot-tons. A gram of protein or a gram of carbohydrates is assumed to yield 4.1, and a gram of fats 9.3, Calories. A given weight of fats is thus taken to be equivalent in fuel-value, on the average, to a little over twice the same weight of protein or carbohydrates. The figures for potential energy in Table I are calculated for each food-material by multiplying the number of grams of protein and of carbohydrates in one pound (1 lb. equals 453.6 grams) by 4.1, and the number of grams of fat by 9.3, and taking the sum of these three products as the number of Calories of potential energy in a pound of the material.

USES OF FOOD IN THE BODY.

The principal functions of food and its nutritive constituents may be briefly summarized in the following statements:

Food supplies the wants of the body in several ways. It either—

1. Is used to form the tissues and fluids of the body;
 2. Is used to repair the waste of tissues;
 3. Is stored in the body for future consumption;
 4. Is consumed as fuel, its potential energy being transformed into heat or muscular energy or other forms of energy required by the body;
- or
5. In being consumed, protects tissue or other food from consumption.

In being themselves burned to yield energy the nutrients protect each other from being consumed. The protein and fats of body-tissues are used like those of food. An important use of the carbohydrates and fats is to protect protein (muscle, etc.) from consumption.

Ways in which materials are used in the body:

Protein forms tissue (muscle, tendon, etc., and fat) and serves as fuel	} Yield energy in form of heat and muscular strength.
Fats form fatty tissues (not muscle, etc.) and serve as fuel . . .	
Carbohydrates are transformed into fat and serve as fuel . . .	

Alcohol does not form tissue, but does serve as fuel . . .

Tea and coffee (thein, caffeine) do not form tissue, do not serve as fuel	} Have various actions upon brain and nerves.
Extractives (meat-extract, beef-tea) do not form tissue, do not serve as fuel . . .	

STANDARDS FOR DAILY DIETARIES.

The demands of different people for nutrients in the daily food vary with age, sex, occupation, and other conditions, including especially the widely-differing characteristics of individuals. The standards in Table IV, herewith, are intended to represent, roughly, the needs of average individuals of the classes named. Nos. 1, 3, 4, 5, and 6 are as proposed by Prof. Voit and his followers of the Munich school of physiologists, and are based upon observations of quantities actually consumed in a considerable number of cases. Nos. 7 and 8 are by Voit, and based both upon quantities consumed by individuals under experiment and upon observed dietaries of a much larger number of persons in Germany. Nos. 9, 10, and 11 are by Sir Lyon Playfair, and are based mainly upon observations of actual dietaries in England. No. 2 has been calculated by myself from the data and results used in Nos. 1 and 3. In Nos. 12, 13, 14, and 15 the data of Voit, Playfair, and other European observers are taken into account, but the conclusions are modified by the results of the studies, elsewhere referred to, of dietaries in the United States, where people, wage-workers especially, are better fed, do more work, and receive higher wages.

Table V herewith, gives the estimated quantities of nutrients and potential energy (fuel-value) of a number of observed dietaries. The European figures are selected from a large number collated by different observers in England, France, Germany, Switzerland, Italy, and elsewhere. Those here cited are mostly by Prof. Voit and his followers in Germany, and Sir Lyon Playfair in England. The American figures were compiled by myself from observations of some fifty dietaries of private families and boarding-houses in Massachusetts, Connecticut, and Canada. Those for the U. S. Army and Navy rations, however, are based upon the U. S. regulations. Unfortunately these estimates have not the entire accuracy which is to be desired, and which can be obtained only by actual weighings and analyses of the food actually consumed in each case. Such painstaking inquiries with collateral study and experiments are much needed, and, in the interests of pure science, of hygiene, and of the practice of medicine, it is to be hoped that they will be carried out.

TABLE IV.
Standards for Daily Dietsaries for People of Different Classes.

NUTRIENTS.					Potential energy.
	Protein.	Fats.	Carbohydrates.	Total.	
	grams.	grams.	grams.	grams.	Calories.
1	28 (20 to 36)	37 (30 to 45)	75 (60 to 90)	140	765
2	55 (36 to 70)	40 (35 to 48)	200 (100 to 250)	295	1420
3	75 (70 to 80)	43 (37 to 50)	325 (250 to 400)	443	2040
4	80	50	200	390	1860
5	100	68	350	518	2475
6	Woman at moderate work, German.....	100	400	2425	2475
7	Man at moderate work, Voit.....	44	500	536	3055
8	Man at hard work, Voit.....	56	500	674	3140
9	Man with moderate exercise, Playfair.....	100	450	695	3370
10	Active laborer, Playfair.....	51	531	701	3140
11	Hard-worked laborer, Playfair.....	71	568	795	3630
12	Woman with light exercise, writer.....	85	568	824	3750
13	Man with light exercise, writer ¹	80	300	460	2300
14	Man at moderate work, writer.....	100	360	560	2815
15	Man at hard work, writer.....	125	450	700	3520
	150	150	500	800	4660

¹Or woman with moderate work. One pound avoirdupois = 453.6 grams. One ounce = 28.3 grams.

TABLE V.
Nutrients and Potential Energy in Dietsaries of Different People.

NUTRIENTS.					Potential energy of nutrients.
	Protein.	Fats.	Carbohydrates.	Total.	
	grams.	grams.	grams.	grams.	Calories.
<i>European and Japanese dietsaries:</i>					
1. Sewing girl, London—wages 93 cts. (3s. 9d) per week.....	53	33	316	402	1820
2. Factory girl, Leipsic, Germany—wages \$1.21 per week.....	52	53	301	406	1940
3. Weaver, England—time of scarcity.....	60	28	398	486	2138
4. Under-fed laborers, Lombardy, Italy—diet mostly vegetables.....	82	40	362	484	2192

5.	Trappist monk in cloister; very little exercise—vegetable diet.	68	11	469	548	2304
6.	Students, Japan.	97	16	438	551	2343
7.	University professor, Munich, Germany; very little exercise.	100	100	240	440	2324
8.	Lawyer, Munich.	80	125	222	427	2401
9.	Physicians, Munich.	131	95	327	553	2702
10.	Painter, Leipsic, Germany.	87	69	366	522	2500
11.	Cabinet-maker, Leipsic, Germany.	77	57	466	600	2737
12.	"Fully-fed" tailors, England.	131	39	525	625	3053
13.	"Well-paid" mechanic, Munich, Germany.	151	54	479	684	3085
14.	Carpenter, Munich, Germany.	131	68	494	693	3104
15.	"Hard-worked" weaver, England.	151	43	622	816	3569
16.	Blacksmith, England.	176	71	667	914	4117
17.	Miners at very severe work, Germany.	133	113	634	880	4195
18.	Brickmakers (Italians at contract-work), Munich.	187	117	675	959	4641
19.	Brewery laborer, Munich; very severe work—exceptional diet.	223	113	909	1245	5692
20.	German soldiers, peace-footing.	114	39	480	633	2798
21.	German soldiers, war-footing.	134	58	489	681	3093
22.	German soldiers, Franco-German War—extraordinary ration.	157	285	331	773	4632
<i>United States and Canadian dietaries:</i>						
23.	French Canadians, working people in Canada.	109	109	527	745	3622
24.	French Canadians, factory operatives, mechanics, etc., in Massachusetts.	118	204	549	871	4632
25.	Other factory operatives, mechanics, etc., in Massachusetts.	127	186	531	844	4428
26.	Glassblowers, East Cambridge, Massachusetts.	95	132	481	708	3590
27.	Factory operatives, dressmakers, clerks, etc., boarding-house, Massachusetts.	114	150	522	786	4002
28a.	Well-to-do private family, Conn.	129	183	467	779	4146
28b.		128	177	466	771	4082
29a.		161	204	680	1045	5345
29b.	College students from Northern and Eastern States; boarding club—two dietaries of the same club.	138	184	622	944	4827
30a.		115	163	460	738	3874
30b.		104	136	421	661	3417
31.	College foot-ball team, food eaten.	181	292	557	1030	5742
32.	Machinist, Boston, Mass.	182	254	617	1033	5638
33.	Brickmakers, Middletown, Conn.	222	203	758	1243	6404
34.	Teamsters, marble-workers, etc., with hard work, Boston, Mass.	254	363	826	1443	7804
35.	Brickmakers, Mass.	180	365	1150	1695	8848
36.	U. S. army ration.	120	161	454	735	3851
37.	U. S. navy ration.	143	184	520	847	4998

In the comparison of the figures of the dietaries of Table V with each other, and with the standards in Table IV, we find the principal data for our present discussion. Let us, first of all, note the difference between the European and the American dietaries in Table V.

Nos. 1, 2, 3, and 4 are those of people regarded as inadequately nourished. No. 1, that of a poor sewing girl in London, contains only 53 grams of protein, and the potential energy of the nutrients is only 1820 Calories, which is just about equal to the subsistence diet proposed by Sir Lyon Playfair,—in other words, just enough to keep body and soul together. The factory woman in Leipsic, Germany, earned \$1.21 per week for the support of herself and child. She had about the same amount of food as the London seamstress. The weaver in England in a time of scarcity, and the under-fed laborers in Lombardy, Italy, had but little more, their diet consisting mainly of vegetables.

Nos. 7 and 8, those of a university professor and a lawyer in Munich, Germany, are more liberal. These persons were reasonably well-to-do, but were not engaged in active muscular exercise. Their food supplied from 80 to 100 grams of protein per day, and total nutrients sufficient to yield about 2300 or 2400 Calories of energy. The diet of the physician in Munich, who may very likely have had active muscular exercise, furnished 131 grams of protein and 2760 Calories of energy.

Nos. 10 to 19 are the dietaries of people in England and Germany engaged in more or less strenuous muscular labor. The daily food of the painter and the cabinet-maker in Leipsic had as much potential energy as those of the professor, lawyer, and physician in Munich, indeed a little more; but it contained considerably less protein. The "fully-fed" tailors in England, and the "well-fed" mechanics in Germany had much more protein, and their food had a high fuel value, 3,000 to 3,200 Calories as compared with 2,500 to 2,700 in those of the Leipsic artisans. The hard-worked weaver and the blacksmith in England, and the miners and brickmakers in Germany, were still better fed, as must needs be with their severer work. The protein in their daily diet ranged from 151 to 187 grams, and the potential energy from 3570 to 4640 Calories.

According to the standards above cited, the Leipsic artisans were inadequately nourished, and the well-fed and hard-worked mechanics and others engaged in active muscular labor were far from over-fed. Voit's standard for a man doing moderately hard muscular work provides 118 grams of protein and 3050 Calories of energy; the one proposed by myself provides 125 grams of protein and 3520 Calories of energy. For a man at hard muscular work Voit's standard calls for 2,520 and mine 4,060 Calories.

The largest of the European dietaries is that of a Munich brewery laborer at very severe work. This is the most generous diet that I have found among several hundred collated by European investigators. It supplies 223 grams of protein and 5,690 Calories of energy per day.

It is interesting to note the dietaries of the German soldiers. The

ration for times of peace furnishes about 2,800 Calories, that for active service in war some 3,100 Calories. The last, No. 22, represents the ration issued by the order of King William of Prussia, afterwards Emperor of Germany, in the early part of the Franco-German war, when the German armies had reached French soil and were engaged in the extremely hard marching and fighting which resulted shortly after in the victories of Strasburg and Sedan. It was a maxim of Frederick the Great, that "if you wish to build up the army you must begin with the stomach," and Gen. Moltke, who was the actual commander of King William's armies, insisted before the German parliament that for an army nothing was so expensive as insufficient nourishment. This ration, which was deemed sufficient for the severest strain put upon the German soldiers, provided about 157 grams of protein and 4,650 Calories of energy per day.

Coming now to the American dietaries, we observe much more generous allowances of food. How accurately these figures represent the food actually consumed by people generally in this country it is, of course, impossible to say. It will be remembered that the figures are taken from observations of dietaries of people in Massachusetts and Connecticut, though a few were from Canada. They were dietaries of people engaged in manual labor, factory operatives and mechanics, except Nos. 28, 29, 30, and 31, which were those of a well-to-do private family in Connecticut, and of college students, mostly from the Northern and Eastern states, in Wesleyan University, Middletown, Conn. Each is calculated to give the amounts of nutrients and energy per man per day.

Of all the dietaries examined, the smallest was that of a glass-blower in Cambridge, Mass., which supplied 95 grams of protein and 3,590 Calories of energy. The average of the dietaries of factory operatives, etc., examined in Massachusetts, was about 127 grams of protein and 4,500 Calories of energy. The well-to-do family in Connecticut considered themselves quite small eaters, and were surprised to find that their daily dietary furnished over 4,000 Calories of energy.

The college students¹ may, perhaps, be taken as representing the eating habits of young men from families of the class to which they belong, namely, those of the more or less well-to-do people of the Northern and Eastern states whose sons go to college. They took their meals in boarding clubs, the food being purchased by one of their number chosen as steward. It will be observed that there was a very considerable difference between the food purchased and that actually eaten, this difference representing the amounts that went to waste. Of course there are corresponding differences in the other dietaries between the food purchased and that actually eaten, but the data at hand do not suffice to show how large these differences were. Dietaries Nos. 29 and 30 are both of the same club: the second was taken after the results of the first had become known. The steward said that the students were just as well satisfied with their diet in the second case, in which the food pur-

¹ In Middletown, Conn. (Wesleyan University).

chased represented 3,875 Calories of energy per day, and that eaten, 3,415 Calories, as in the first, when 5,345 Calories were furnished by the food purchased, and 4,325 by that eaten. The college foot-ball team was engaged in very active exercise. The potential energy was estimated at 5,740 Calories per day.

The brickmakers in Middletown, Conn., and the teamsters, marble-workers, etc., in Boston, were engaged in severe muscular labor. Their dietaries furnished from 220 to 250 grams of protein, and from 6,460 to 7,800 Calories of energy per day, while that of the brickmakers in Massachusetts rose to 8,850 Calories of energy per day.

Let us repeat here, that there is one difficulty with all these computations, namely, that we do not know how exactly they represent the food actually consumed. The only way to get the exact figures would be to weigh and analyze the food actually consumed each day in each case. This ought to be done, and when it is done will certainly give results of the highest interest and value. But however inaccurate the estimates here cited may be, it seems hardly reasonable to believe that they can be extremely wide of the truth.

Comparing these with each other and with the dietary standards, taking the potential energy as the basis, it is interesting to note the much larger amounts of food consumed in the American than in the European dietaries.

Leaving out the very poorly fed persons, the European figures range from, say, 2,300 to 4,000 Calories. The German standard for a man of moderate muscular exercise requires 3,050 Calories. The smallest of the American dietaries has 3,600 calories, the largest, 8,850. Roughly speaking, both the protein and the energy in the American dietaries exceeds those of the European by about 50 per cent.

The university professor, the lawyer, and the physician in Munich, Germany, found themselves well nourished with from 2,325 to 2,760 Calories; the people in corresponding occupations in Connecticut have from 3,415 to 5,345. The college students, with only light muscular exercise, have as much as the German soldiers under the severest strain of the Franco-German war. The relation between food and intellectual labor or nervous strain is not well understood, and is one of the subjects that pressingly demands experimental study with the appliances that modern science suggests. But I have been unable to find any facts that seem to me to sustain the theory that such large quantities of food are needed for mental effort.

This brings us to the root of the matter. It is doubtless well that the people engaged in hard muscular labor should have large quantities of nutritious food. But is it needful that people of sedentary habits in this country should eat so much? If these figures are to any degree a fair representation of our eating habits, are we not guilty of extreme immoderation? Are we not intemperate in our eating, as we are in our drinking?

I make these suggestions in the form of questions rather than positive statements, partly because the data lack the absolute accuracy that is

needed, and partly because I am well aware that it behooves the chemist to be careful in expressing opinions regarding matters outside his specialty. But, as I have collated these figures, and compared them with each other and with the frequent statements I hear from physicians and others regarding our eating habits and the evils that result from them, I have been struck very forcibly by the way those statements and these figures agree.

The data here given suggest a number of topics for consideration, which I can only refer to most briefly, regretting that there is not opportunity to discuss them.

The generous amounts and the nourishing character of the food of American laboring people enable them to do a great deal more work than the European. For this they get higher wages. Other factors come into play to decide the amount of work done, such as superior intelligence, skill in the use of machinery, etc., but I am persuaded that the food is one of the chief, if not the chief. Of course this is not a matter about which a physiological chemist may assume to speak with authority. But the data at hand indicate that the average European workingman is not fed up to his highest producing capacity, and experimental evidence implies that, regarding the body as a machine, the richer food not only means more fuel, but makes the machine itself stronger.

Such facts as those given in these comparisons of American and European dietaries imply that the average laboring man here has what only the exceptionally well-fed man has on the other side of the Atlantic—the food he needs to make the most of himself and his work. There are in this country and in Europe instances in plenty to illustrate what seems to be a general principle, that liberal food, large production, and high wages go together. If it be true that the amount of work done is one of the chief regulating factors of the rate of wages, then the connection between the American's generous diet and his high wages is very clear.

If the statements of numerous writers on physiology and hygiene are correct, one chief cause of corpulence is over-eating. It is interesting to note that such dietaries as those of Banting and Ebstein, when reduced to terms of protein and energy, prove very small indeed. Thus the regimen of the Banting system provides only about 1,100, and that of the Ebstein system 1,400 Calories per day. It is very easy to see why, if these are followed, the amount of fat stored in the body could be rapidly reduced.

It was suggested above, that one chief difficulty with our diet is excessive use of meats and sweetmeats. The details of the analyses of meats and of the composition of the dietaries, of which the condensed results are given in Tables I and V, emphasize this very forcibly, and it is not difficult to see how it comes about, most naturally, that, with the popular ideas of the need of abundant and nutritious food, the ease with which such food is obtained with us, and the lack of specific information on these subjects, we should get into the way of gratifying our palates with little regard to the effect upon our health.